Los Alamos Physics Summer School

Program Description

The Los Alamos Summer School, a joint program of the University of New Mexico (UNM) and the Los Alamos National Laboratory has just completed its twelfth full year. The School targets upper-level undergraduates students, who will soon be making career choices, and recruits nationally to gain the most diverse possible class. We give the students an intense exposure to basic research by concentrating on many fascinating, diverse areas of physics, both through lectures by distinguished scientists on the latest developments and through mentored term projects. These areas include such diverse disciplines as astro-, weapons, condensed-matter, plasma, bio-, laser, atomic, molecular, and optical physics. We also have the broader goal of teaching certain basic physics skills not commonly emphasized in the university curriculum, of introducing high-performance supercomputing, and of fostering a personal interaction between research scientists and students. A knowledge of the workings of scientific research, of the frontier discoveries, and of the newest computer techniques will greatly aid students, no matter what their ultimate career choice. For the past nine years, the School has been funded by a National Science Foundation (NSF) Research Experience for Undergraduates (REU) site grant to UNM and by the Science Education Programs at the Laboratory through a DOE Defense Programs grant in addition to in-kind support from the Theoretical (T) Division and the UNM Center for Graduate Studies and the Department of Physics and Astronomy. This year witnessed a new funding component of a direct grant from line management within the Nuclear Weapons Program at the Laboratory.

The session divides into two complementary activities involving lectures and a mentored student research project. First, the lectures focus on current "hot topics" in the field of physics, motivated from the speaker's own research projects. The lecturer introduces basic physical concepts from the perspective of ongoing research endeavors. This mode of presentation gives the students an opportunity to participate in new investigations. Second, each student works on a research project for the whole summer term. A mentor from the senior scientific staff of the Laboratory or UNM oversees and guides the student through this endeavor. A variety of projects are available; many center heavily on high-performance supercomputing. The mentors carefully craft each research project to fit the background of the student in order to guarantee the greatest and most effective participation. We have found that this dual track of lectures and research best stimulates in the students an active interest in science and avoids the pitfalls of a program devoted exclusively to one track or the other.

For 2001, we kept the ten-week term begun two years ago at the behest of students and mentors, who felt the extra time lead to more productive

projects. Given the enthusiastic response to this year's projects, we could easily extend another two weeks. The students received three hours of course credit from UNM as Physics 501. This credit has been readily transferred to home institutions and, in many cases, has substituted for a senior research project. We scheduled lectures in the mornings and reserved afternoons for research (Figs. 11, 12, and 13), attempting to strike a balance between these two activities. Classes and computer sessions were held on the campus of UNM at Los Alamos; the UNM computer center has a fast link to the Laboratory network while providing powerful local capabilities. The common class and computer rooms as well as their close proximity within student housing all encouraged a natural cohesiveness within the class. We further fostered this class spirit with tours of Laboratory facilities and of local points of interest and activities. The friendships made during the course of the School form an important, enduring feature of the program as commented upon by almost all students, past and present.

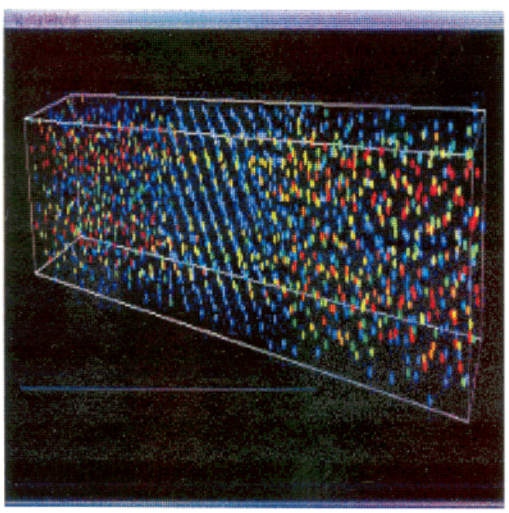

Figure 11. Molecular dynamics simulation of nickel near melt.

While this basic formula has served the School admirably over its course, we continue each year to experiment with new educational projects and approaches. These experiments function on a small enough scale so as not to endanger general student performance, yet with a broad enough

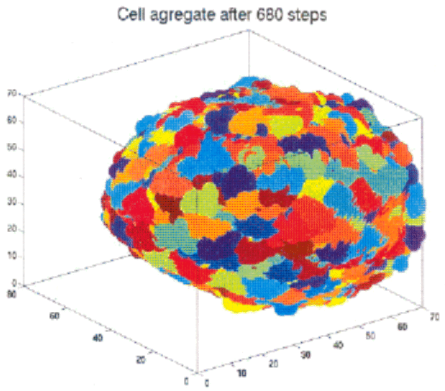

Figure 12. Avascular tumor.

scope to provide reasonable extrapolation. This year we developed two special sessions: (1) Physics and Society; and (2) a Conference Experience.

Performance Objectives and Milestones

The main performance objective centers on the planning and operation of the School to encourage undergraduate students to pursue research careers in the basic sciences, important to the DOE/DP mission. This has become critical as biotech and computer firms now attract the best university students. The short-term milestones of providing exciting projects and lectures to stimulate the students have been amply met. For the intermediate term, we have repeatedly had students return to the Laboratory to continue research activities, students working on advanced degrees with joint Laboratory and university mentors, and students begin tenured-track university positions with continued strong ties with Laboratory personnel. Since the time these undergraduates may take to a doctorate could span seven or eight years, we are just beginning to glimpse the long-term effects of the program.

Program Highlights 2001

Reflecting the dual nature of the sponsorship, we have co-directors with each taking particular responsibilities for various tasks in operation and organization, based on resources, personnel, and

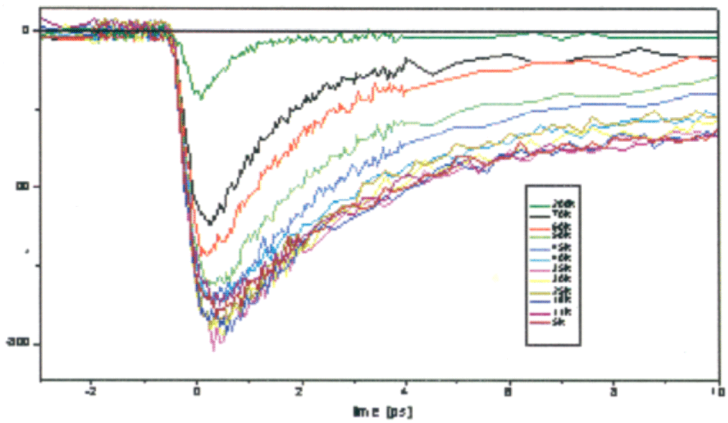

Figure 13. Pump-probe (1.5 eV) on $YbIn_4Cu$.

location. For example, UNM has excellent facilities and staff at its several locations to handle the vital task of recruiting and to provide classroom and computer access, while the Lab has the on-site technical staff from which to draw the mentors and lecturers. Professor Sally Seidel serves as co-director for the UNM side, and Dr. Lee Collins for Los Alamos. Prof. Howard Bryant, a co-principal investigator on the NSF grant, provides invaluable service in many areas of the program. The School could not function without the immeasurable contributions of Norm Magee (Laboratory group T-4), Drs. Daniel James (T-4) and Dana Berkeland (P-23), who assisted in the planning and operation of the program.

Mentored Research Project

In 2001, twenty students from universities in thirteen states participated in the combined curriculum of lectures and individual research projects. We had our largest participation of mentors to date, beating last year's record, representing seven different Laboratory divisions and seventeen groups as well as UNM. Twenty projects, supervised by twenty-seven mentors, covered such diverse areas as quantum computing, plasma shocks and confinement, neutrino oscillations, ultracold systems, viral infections, fuel cells, materials simulations, and femtosecond spectroscopy and ellipsometry. Topics and principal mentors appear in more detail in Table 8.

All students submitted detailed final reports, crafted along the lines of a standard scientific paper, on their research accomplishments. The papers will be bound into a Laboratory publication (LA-UR-01-4922) for general distribution. To aid in writing these reports, we held a special class on technical writing, given by Dr. Collins, who also serves as an editor to *The Physical Review*. The main emphasis of the School centers on the research *experience*, giving the students a taste of a hands-on technical project. The span of the program remains generally too short for the production of a finished, polished, and publishable piece of scientific research. However, four students already plan to continue work on their projects, either as independent endeavors or as a part of their senior research course at their respective institutions. We anticipate publications in refereed research journals from these continuing efforts. In fact, recent publications from former students of research associated with the School include articles in *Physical Review Letters* [1], the *Journal of Vacuum Science and Technology* [2], and the *Journal of Acquired Immunodeficiency Syndromes* [3].

This year, the Laboratory expanded its annual student poster session into a full scientific meeting, Symposium 2001, that included student talks and posters as well as presentations from universities and corporations. Although the School comprises less than 1% of the student population at the Laboratory, almost 10% of the

Table 8. Mentors (affiliation) and Research Projects

Mentor/Affiliation	Research Project Title
M. Taccetti (P-24)	
Magnetic Induction Probing Techniques for Magnetized Target Fusion	
F. Cherne (MST-8)	
Examining Properties of Materials with Molecular Dynamics: A Study of Nickel	
M. Holzscheiter (P-23)	
Stability of Pure Electron Plasma in Inhomogeneous Magnetic Fields	
W. Hlavacek (T-10)	
Activation of Complement by HIV and Complement-Mediated Attachment of Virus to Follicular Dendritic Cells	
S. Cohen (LANSCE-6)/ H. Bryant (UNM)	
Searching for H^- Resonances in Stellar Atmospheres	
R. Kanzleiter (X-2)	
Analysis of Near Analytic Solutions to Converging Shock Waves in a Cylindrical Geometry	
D. James/J. Grondalski (T-4)	
Teleportation as a Measure of Entanglement	
M. Murillo (T-15)	
Molecular Dynamics Calculation of Yukawa System Phase Diagram	
G. Bender/ A. Saab (MST-11)	
Automation of Membrane Electrode Assembly Production for Polymer Electrolyte Fuel Cells	
A. Hime (P-23) / M. Dragosky (C-INC)	
Data Analysis of the Ratio of Background to Signal from ^{252}Cf Calibration Source for Sudbury Neutrino Observatory	
E. Ben-Naim (T-13)/ R. Ecke (MST-10)/ Z. Daya (T-CNLS)	
Topological Constraints in Vertically Vibrated Granular Chains	
E. Liong (P-21)	
High-Throughput Isolation of Biological Macromolecules	
Hui. Li (X-1)	
Magnetorotational Instability of Liquid Sodium Couette Flow	
Yi Jiang (T-7)	
Cellular Model for Avascular Tumor Growth	

Symposium 2001 participants came from our program. Our students gave two talks and nine poster presentations. One student, Jonathan Schauer, was awarded the Best Undergraduate Poster prize—quite an accomplishment for a small group over such a short period.

Several of our past students returned to the Laboratory to work with various research groups, based on contacts and projects initiated with the School. One of the students, Anne Arroyo (LASS00), completed a master's degree in physics with Dr. Dana Berkeland (P-23) and her research Professor at California State at Fullerton, Heidi Fearn. Another student, Daisy Raymondson (LASS99), plans to work toward an advanced degree with Dana and her advisor at UC Davis.

Lectures

In addition, the students attended a full set of lectures on an extensive range of topics as outlined in greater detail in Table 8. These lectures serve as a perfect vehicle to highlight the

expansive, high-quality research programs of both institutions and provide a marvelous recruiting opportunity. Distinguished lecturers were drawn from outside universities and research organizations, from the University of New Mexico, and from the Laboratory [6 divisions and 18 groups!]. The almost immediate filling of all lecture slots upon announcement of the program attests to the popularity of the School amongst a broad range of scientists at the Laboratory. The talks give staff a rare opportunity to address in an informal setting a group of highly talented students. The outside participation was our largest yet including Prof. N. Lane (Rice), Prof. E. Weigold (Australian National University), Prof. J. Eberly (Rochester), Profs. P. Gould and J. Javanainen (Connecticut), and Prof. H. Fearn (Cal State). We continued our strong participation from UNM, which highlights the important ties between the University and Laboratory generated by this program. We again drew upon the enthusiastic participation of the junior scientific staff at Los Alamos, mainly from postdoctoral fellows.

This opportunity often provides their only experience in preparing and giving lectures to a student group.

We continued our broader program on Physics and Society. In addition to our regular introductory lectures concerning the place and responsibilities of science in the world and culture, we had a very special segment given by Prof. Neal Lane, past Presidential Science Advisor. This involved an informal talk exclusively to the Summer School class, allowing ample time for questions and interactions. The talk proved the most popular single event of the School. Several of the students have already begun to correspond with Prof. Lane on the stimulating, thought-provoking points of his presentation. Additional projects through the term built upon these links to cultural ideas, for example, through a talk and class trip to a performance of the Santa Fe Opera.

The lecture series has been open to all other Laboratory educational projects, and we have routinely distributed the schedule to the undergraduate (UGS) and graduate (GRA) programs. Many of the lectures were attended by students from other programs.

Activities

In addition to the formal lecture and mentor programs, we have arranged for a wide variety of related activities for the students. We had tours of various Laboratory facilities including the Neutron Scattering Center (LANCE), quantum computing laboratories, and the pulsed-power Atlas facility. Our traditional Night at the Santa Fe Opera (SFO) continued by attending *Mitridates*. We have over the years fostered a special relation with the SFO and have been able to acquire block tickets so that the whole class can conveniently attend a single performance. This event reflects a trend in recent classes, especially given our recruitment from liberal arts colleges, of dual majors in the sciences and the arts.

As a special activity, the students attended the International Conference on Photonic, Electronic, and Atomic Collisions (ICPEAC) held in Santa Fe in July. We concentrated this conference experience into a single day that included plenary, invited, and poster sessions as well as the reception. Most of the class had not attended a major scientific conference so this gave an intense overview of the many activities and operations of such a professional gathering. The poster session proved particularly popular since the class got many ideas for their own presentations later at Symposium 2001. For this coordinated endeavor, we drew upon our past success in the Conference Experience for Undergraduates program [4], also funded by EPO and NSF. The International Organizing Committee, and especially the local group, headed by Dr. Jim Cohen (T-4 group leader), provided invaluable and enthusiastic assistance.

Recruitment and Demographics

Unlike most REU sites, we recruited nationwide with an emphasis on students from schools with little or no graduate research programs. The University of New Mexico handled the recruitment phase, consisting of an extensive mailing of fliers to all members of several American Physical Society Divisions (about 2000). In addition, a color poster was sent to most physics, chemistry, and astronomy departments in the United States. Special mailings went to minority-designated institutions. We have worked closely with other efforts within the science education area at the Laboratory, including the Historically Black Colleges and Universities program. We have also developed a Website [http://www.phys.unm.edu/LASS] that gives general information and allows direct applications. For 2001, we received over 115 applications, up slightly from last year, and admitted twenty students (Figs. 14 and 15).

This class was very strong scholastically, filled with many honors students. The students came from nineteen different universities from Massachusetts to California. These included liberal arts colleges with small research programs to large research-oriented schools. Our participation by women held this year at 20%, still down from several years ago. This reflects a trend noted at other REU sites and appears related to a greater degree to competition among programs rather than a drop in participation or graduates. Other underrepresented groups included Native-American (1), Afro-Americans (1), and Asian (1) participants.

Schools
Luther College (IA)
Allegheny College (PA)
Bard College (NY)
Fort Hays State University (KS)
University of Nevada-Reno (NV)
University of Minnesota-Morris (MN)

Figure 14. Summer school participants.

University of Rochester (NY)
University of South Alabama (AL)
Berea College (KY)
University of California-Riverside (CA)
Cornell University (NY)
Ramapo University (NJ)
Concordia College (MN)
Harvard University (MA)
University of Massachusetts (MA)
Hendrix College (AR)
Arizona State University (AZ)
Drake University (IA)
Drexel (PA)

Figure 15. Student participants.

Evaluation

Evaluation of such a project has always been difficult. We performed an impact evaluation, asking the students the immediate importance of their participation in the School. The consensus this year followed remarkably closely that of previous years. The following general findings about the course emerged: (1) well organized and at about the right level, (2) helped improve understanding of basic concepts in the field, (3) required a reasonable amount of work, (4) provided skills applicable to their careers, (5) gave appreciation of high-level computer power, and (6) fostered an informality that nurtured interactions with renowned scientists. We were gratified with the response from most of the students that the School had " renewed their interest in science and computation." Therefore, the short-run effects of the School were clearly very positive.

This year, Prof. Bryant made a concerted effort to contact students from the previous few classes; those for which we still had fresh tracks in cyberspace. About 30% of these students responded. All indicated that they have continued in the physical sciences and plan to seek advanced degrees. An interesting and encouraging trend emerged regarding liberal arts students, which we have diligently recruited. All that responded have been accepted into top-flight graduate schools in science, including the University of California, Cornell, Johns Hopkins, the University of Chicago, and Yale, to list but a few. The students continue with their praise for the program and their regard for the Laboratory's research programs.

In a departure from the usual staid nature of such reports, we include in an Appendix an important gauge of success of any program: anecdotal information from some of our students taken from this recent survey.

Budget

The FY00 budget ran at $195,000 with $70,000 from the NSF-REU grant and $100,000 from Nuclear Weapons line management, and $25K from Science Education programs. In addition, considerable in-kind support (~$70,000) comes from both institutions including materials, computer time, and staff. In addition, T Division provided a $10K special grant. The students were paid a stipend of $4500 for the session that covers UNM tuition, travel, and subsistence. Housing costs, always a major expense in Los Alamos County, were borne directly by the School. The difficulty in obtaining housing during the summer and the expense was greatly reduced by having new UNM housing available to the School. In addition to being enrolled as nondegree students at UNM, students are placed on assignment at LANL so as to utilize the many facilities such as the Library as well as to provide easy access to the mentors.

DOE/DP Mission Benefit

The School began as an internally-funded project within the Los Alamos Weapons Program to encourage greater participation by outstanding students in research areas deemed vital to many DP missions. With the funding and policy changes of 2001, we have, in some respects, returned more strongly to this initial purpose.

The basic goals of the Los Alamos Summer School closely align with recommendations of the Chiles Report, especially item 7, to "replenish the essential work force needs" of the weapons laboratories. Specifically, the program gives high profile and presence through its national recruitment process that targets both students and teachers at over 2000 universities and colleges, its use of distinguished lecturers from outside academic institutions, and its alumni.

The School serves as a ten-week intern program in which students become actively involved in a variety of research programs around the Laboratory. In addition, our classes have had strong participation by women, consistently at a percentage well above of that in university physics programs at the same level. We have also employed many women scientists as mentors and lecturers to serve as role models.

Programs like the Summer School, which concentrate on undergraduate students, provide a unique and powerful vehicle for captivating and recruiting highly-talented students with tremendous career potentials into areas of critical interest to the national security in general and to DOE in particular. As indicated by our evaluations, the Los Alamos Summer School fosters in students an extremely positive view of the Laboratory and its multifaceted research programs. We must build on this enthusiasm with a coordinated series of interlocking programs that follow and attract students all along the lengthy path to a professional degree.

References

[1] D. Morr, T. Trautman (LASS), and M. Graf, Phys. Rev. Lett. **86**. 5978 (2001).
[2] D. Hanson, B. Stephens (LASS), C. Saravanam, and J. Kress, J. Vac. Sci. Technol. **19**, 820 (2001).
[3] D. Roberts (LASS) and M. Ribeiro, JAIDS **27**, 331 (2001).
[4] L. Collins, N. Magee, H. Bryant, and. M. Zeilik, Am. J. Phys. **67**, 685 (1999).

Student Comments

"Hello - I hope no one minds a reply to the group! I at least am interested in what the other alumni are up to, and hopefully this mass response doesn't offend anyone. I'm preparing to start my second year in grad school at UC Berkeley. I've been working this summer (and last) on the CDF experiment (one of the two colliding beam experiments there) at Fermilab....So, I'm not doing anything too directly related to my time at LASS. But, I would like to (re-) affirm that it was a wonderful program and an enriching summer. The morning lectures were especially useful giving me a much broader perspective on current research (especially in atomic and optical systems, and condensed matter) than I could have otherwise gotten. I'd also like to affirm the diversity of lectures that were offered [i.e., not just atomic, molecular, and optical (AMO) physics]. Especially Sally Seidel's overview of the Standard Model - being the most directly related to what I'll be up to these next few years! I hope everyone's well, and would love to hear from the rest."
Adam—July 30, 2001, Class of 1999, UC Berkeley/LBL

"Hello, I am currently doing an REU at Cornell's CESR. I graduate in spring 2002 from Florida State and am doing an honors thesis on Monte Carlo simulations of phase change dynamics using an Ising lattice-gas model. I hope to pursue graduate studies in physics. I am strongly considering quantum information for a

PhD thesis topic and have been trying to pursue this field since the lectures I attended at LASS last summer. I hope this helps LASS continue to motivate and educate eager physics majors." Thank you,
Daniel—July 30, 2001, Class of 2000

"Hello, I'd be glad to give you some info. I thought LASS was great and I'd like to see it continue. I graduated in May 2001 from Wayne State with a B.S. in Physics and a B.S. in Mathematics. I'm beginning grad school (for physics) in September at UC Santa Barbara. I'm not sure yet what I plan to study, but I'm sure it will be theory of some sort. If you want more, don't hesitate to ask." Regards,
Eric—July 30, 2001,Class of 2000

"Dear Howard, After LASS 2000 last summer I went to graduate school at the University of Glasgow in Scotland. This summer I have returned to Los Alamos to work again with the mentor I had with LASS. The research I am doing this summer is a continuation of my LASS project last summer. This work will be included as part of my PhD thesis in Glasgow. I will most likely return to Los Alamos as a GRA within the next year. Hope this helps. Best wishes, Rejean"—July 30, 2001, Class of 2000

"hey guys...i plan to go back into academics when my stint with the military is up, probably getting my phd in particle/high energy theory (or perhaps condensed matter theory). i worked with dirk morr last summer on superconductivity. our paper just recently got accepted by physical review letters, if he did not tell you, i was very excited about that one. LASS was my third summer science thing, this was the first paper i got out of it. plus the class was incredible and the people were unusually cool too."

".... you have the only unique/really ingenious reu type program on the market.
pete"—July 30, 2001, Class of 2000

*"Hello Dr. Bryant, My Name is Arlene * and I attended LASS 2000. I will go to Texas A & M University in the Fall in their PhD Physics Program. High Energy Physics/Nuclear Physics are my interests at this time."*
Arlene—August 1, 2001, Class of 2000

"Hello everybody. I will be starting my third year of physics grad school this fall at the Univ of Chicago (I'm feeling old here). I'm working with Sean Carroll on cosmology and particle physics—specifically, I'm trying to figure out if quintessence can explain both the time variation of the fine structure constant and the accelerating universe. I really enjoyed my summer in Los Alamos, in fact, that was my most productive/ fruitful summer by far as an undergrad. I learned some physics, I learned that there was more physics than I could ever possibly know, and I learned to swing dance (or I tried). Thank you LASS for that unique opportunity. Take care,"Jennie—August 3, 2001, Class of 1999